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INTRODUCTION TO REPORTS OF THE FOREST SURVEY OF THE LAKE STATES

PURPOSE, METHODS, STANDARDS AND DEFINITIONS

LAKE STATES FOREST EXPERIMENT STATION
UNIVERSITY FARM — ST. PAUL, MINNESOTA.
U. S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE

PUBLICATION OF THE

LAKE STATES FOREST EXPERIMENT STATION*

RAPHAEL ZON, DIRECTOR

***

FOREST SURVEY STAFF

R. N. Cunningham	Regional Director
H. C. Moser	Assistant
J. A. Diemer	Administrative Assistant

Inventory:	E. L. Lawson, Field Chief
	R. J. Woolery, A. Downs, D. M. Knight, M. W. Day, A. F. Lehmann, J. O. Grove
Growth:	S. R. Gevorkiantz, Wm. A. Duerr, R. T. Anderson
Drain and Requirements:	H. G. White, C. J. Holcomb, C. H. Stoddard
Special Studies:	L. W. Schatz, C. Markkanen, H. G. Gafvert

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Introduction to Reports of the Forest Survey of the Lake States

Purpose, Methods, Standards, and Definitions

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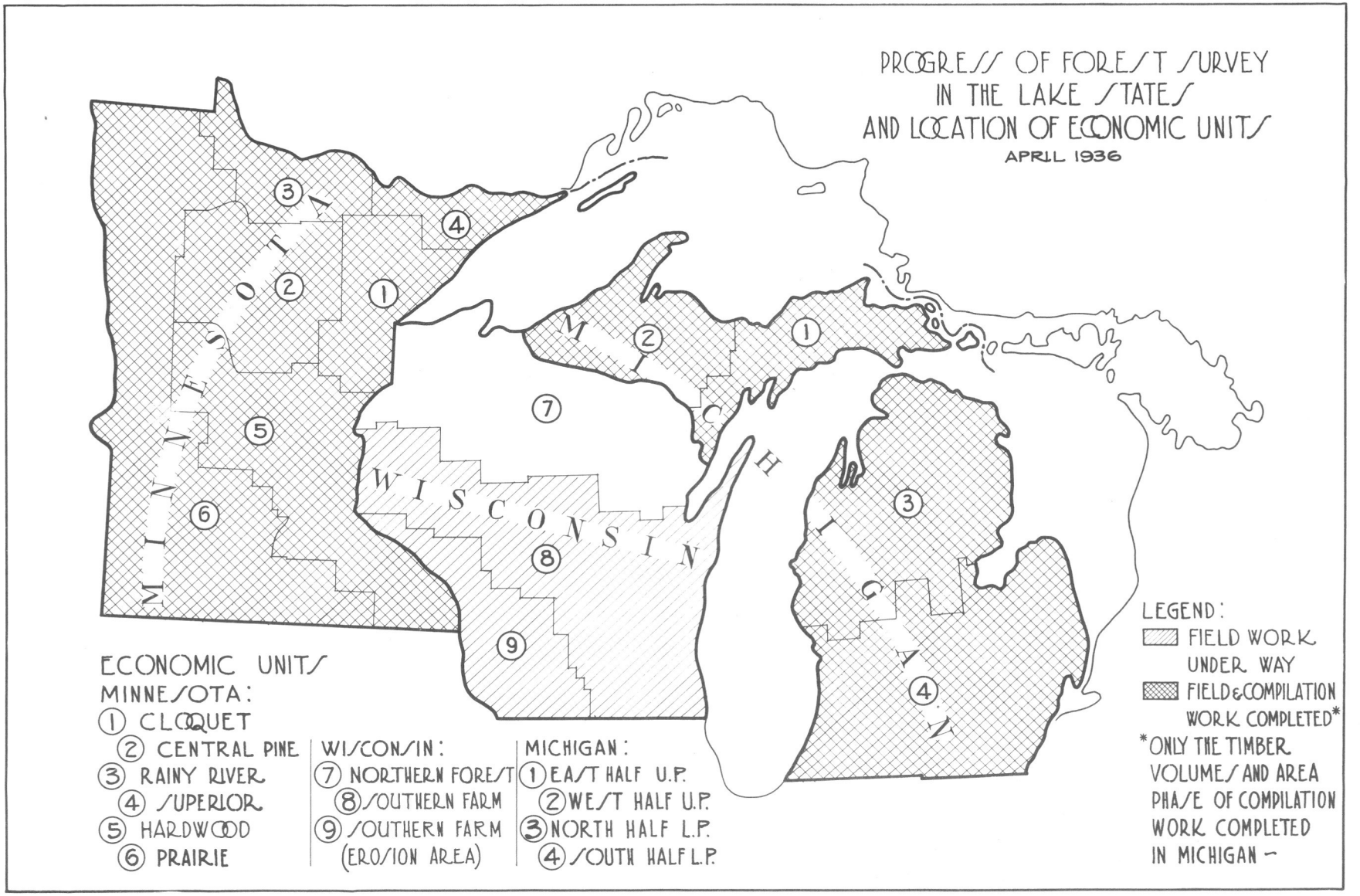
PROGRESS OF FOREST SURVEY
IN THE LAKE STATES
AND LOCATION OF ECONOMIC UNITS
APRIL 1936
MINNESOTA
WISCONSIN
MICHIGAN
ECONOMIC UNITS
MINNESOTA:
1 CLOQUET
2 CENTRAL PINE
3 RAINY RIVER
4 SUPERIOR
5 HARDWOOD
6 PRAIRIE
WISCONSIN:
7 NORTHERN FOREST
8 SOUTHERN FARM
9 SOUTHERN FARM (EROSION AREA)
MICHIGAN:
1 EAST HALF U.P.
2 WEST HALF U.P.
3 NORTH HALF L.P.
4 SOUTH HALF L.P.
LEGEND:
FIELD WORK UNDER WAY
FIELD & COMPILATION WORK COMPLETED*
*ONLY THE TIMBER VOLUMES AND AREA PHASE OF COMPILATION WORK COMPLETED IN MICHIGAN –

Introduction to Reports of the Forest Survey of the Lake States

Purpose, Methods, Standards and Definitions

INTRODUCTION

To fulfill a long-felt need for reliable information on the forest resources of the country, Congress, in the McSweeney-McNary Forest Research Act of 1928, authorized the Forest Service to undertake a nation-wide forest survey. The survey was started in the Douglas Fir Region of Oregon and Washington. Later it was extended to the South, the Lake States, California, and the Inland Empire. In the Lake States work was begun on an extensive scale in 1933 by the Lake States Forest Experiment Station.

The five-fold objective of the Survey is (1) to take stock of the present supply of timber and of the forest lands available for growing timber, (2) to ascertain the current rate of timber growth and the potential yields of forest products under different types of management, (3) to determine the rate of depletion by industrial and domestic uses, windfall, fire, insects, and disease, (4) to determine the present consumption and the probable future trends in the requirements for forest products, (5) to correlate these findings with existing and anticipated economic conditions in order that policies can be formulated for the effective use of the land available for forest production.

The field work of the Forest Survey in the Lake States is rapidly nearing completion. Two states, Minnesota and Michigan, have been completed and the third, Wisconsin, probably will be covered during 1936. Each state has been divided into districts, or Economic Units of four to fifteen million acres each. Data have been compiled separately for each such unit so far as possible.

The results of the survey are being made available through a series of reports. These reports are of several types:

1. Statistical releases which report the factual data compiled by the Survey concerning timber volumes, forest areas, industries, etc. They are issued without accompanying textual analysis and without attempt to point out the significance of the data.
2. Unit Reports, which embody not only the statistics compiled for each economic unit but also a comprehensive analysis of all features of the forest situation.
3. Final reports for a State or Region which will present a full analysis of the findings of the Survey. Ultimately, the information for the several states will, with proper consideration given to the influence of other forest regions, indicate the place of the Lake States in the national program.

The purpose of this ntroduction is to make available a detailed description of the methods used in the survey, to describe the standards of estimating, and to define the several bases of classification employed in compiling and presenting the data. It is suggested that this Introduction be kept for reference in connection with later Forest Survey reports to be issued by the Lake States Forest Experiment Station.

PLAN OF SURVEY

Inventory of Forest Areas and Timber Volumes

Practically all timber surveys are made by a process of sampling rather than by a complete coverage of the entire area. In the forest survey of the Lake States the sample was obtained by running east and west lines ten miles apart across the full width of each economic unit, and by taking small circular sample plots at regular intervals along these lines. The plots were one-fifth acre in size and were spaced regularly at 40-rod intervals - eight to the mile. For example, in a survey unit of 5,000,000 acres, about 800 miles of line would be run and 6,400 sample plots measured. The field work was carried on by

estimating crews of two men each.

Sample plots were classified on the ground as to type, size of timber, density and certain other supplemental data. Later, the ownership was determined and added to the plot classification. The number of plots in each classification was used as a measure of the extent of the condition in the unit. For instance, if 20 percent of a total 6,400 plots in a unit were classified aspen, it was assumed that 20 percent of the surveyed area was aspen. Similar assumptions were made as to size-class of timber, density, and ownership. The reliability of these assumptions is discussed in a later section.

On each plot a tally was made of the living trees of timber species. Over the entire fifth-acre all trees 5.0 inches and larger in diameter at breast height were tallied by species and diameter classes. Four-inch trees were tallied on only one-eighth of the plot, and 2-inch trees on only one-twentieth of the plot.

In the office, the tallies for all plots of identical classification were combined into an average stand table which showed the average number of trees per acre of each species and diameter.

To secure estimates of timber volumes, tables were compiled which showed the volume of sawtimber, pulpwood, etc., in the average tree of each diameter and species. Such tables were based upon measurements of volume, heights, and utilization of sample trees taken on the sample plots and on sample trees from all logging operations in the district. Estimates of the average volume per acre for each species and diameter class were obtained by the application of these tables of average volume per tree to the stand tables which showed the average number of trees per acre. Expansion of the average stock tables thus compiled, in proportion to the acreage of the condition class, indicated the total volume of timber in the survey unit.

In making the tally of trees on the sample plots, trees which were totally unmerchantable because of form or defect were tallied separately and such trees

were not included in the estimates of merchantable volume. A further reduction of the gross volume of the merchantable trees was made to allow for defect. On the basis of measurements taken on logging operations, supplemented by estimates on standing trees, the amount of wood left in the woods was determined. Milling losses due to sweep, check, rot, and other defects were determined by a scale of cut logs and by a study of mill output. The several types of cull were averaged for each species and used as a cull factor to reduce gross volumes to a net volume basis.

The general method of survey outlined above is being employed throughout the Lake States, with the exception of two economic units in Minnesota. In those cases the estimates of volume and area were based on a compilation of existing data. Details of the methods used will be explained in the reports covering those units.

Ownership of Timber and Forest Land

Ownership was determined from county records and was added to the plot classification. Estimates of area and volume of each forest cover type were broken down in proportion to the number of plots of each ownership class.

Tax records in the office of the county auditors and treasurers were used for determination of ownership. For the purposes of this survey it was assumed that the owner was the person in whose name the land was assessed. Although this is not always the case as to individuals, it is largely true with respect to ownership classes.

Growth and Yields

Net growth in an undisturbed stand of timber is the resultant of two opposing influences: the first is increase in the size and number of merchantable trees; the second is mortality - death or destruction by natural causes of certain trees - resulting in decreased numbers and volume.

Short-term Growth

The expected net increase in board foot and cubic foot volumes during the next 10 years was calculated for each cover type and size class of timber in each

survey unit. Borings made on sample trees from the sample plots served to determine the 10-year diameter growth of the individual trees, and permitted an estimation of the gross volume of the stands 10 years hence if none of the trees now living, died. Many of the trees now assumed to have no board foot or cubic foot volume may be expected to grow to merchantable size during the next 10 years, thereby becoming a factor in the volume growth of the stand.

To adjust these gross volumes to take care of the death and natural losses which may be expected in every stand during a 10-year period, a mortality factor was applied. The basis for the mortality deductions was provided by a study of typical stands in each of the cover types and size classes of timber. This study showed that as a stand increases in size, the number of trees decreases at a definite rate. There is apparently a strong relationship between the average diameter of the stand and the number of trees in the stand.

With the probable diameter growth during the next 10 years predicted from the increment borings for each cover type and size class, it remained only to find the mortality (actual number of trees expected to die) corresponding to the change in average diameter and apply it to the several types and conditions. This numerical mortality was converted to a volume basis, using the stand tables and volume tables compiled in connection with the volume inventory.

Long-term Growth

To provide a basis for estimating growth for longer periods, special yield tables were prepared for each type. For types such as aspen, white and Norway pine, where normal yield tables had been made previously, these tables were adjusted to conform to the standards of the present survey and were used with suitable discounts for understocked conditions. For other types, empirical yield tables were prepared. This was done by determining the volume and age of a large number of plots in undisturbed stands. Many of these plots were given a permanent marker so that they could be remeasured in five years as a check upon estimated

growth rates.

Depletion

Drain on the present timber stands is of three general types: (1) Industrial and domestic use, (2) fire damage, (3) miscellaneous losses from insects, disease, tornadoes, etc.

Industrial and Domestic Use

The current drain by sawmills and other primary wood-using industries was obtained from a variety of sources.

In Minnesota, a complete canvass was made of all sawmills (except those few small mills which are scattered throughout the prairie district).

In Michigan, statistics on the majority of the large mills were provided by the Northern Hemlock and Hardwood Manufacturers' Association. These data were supplemented by a direct canvass of the remaining large mills and by a complete coverage of smaller mills in selected representative counties. In the Lower Peninsula a complete survey of small mills and other wood-using plants was conducted by Professor W. F. Ramsdell of the School of Forestry and Conservation of the University of Michigan. His records were made available to the Survey.

Estimates of the consumption for domestic use of such products as fuelwood, posts, etc., were based on intensive studies in representative counties, supplemented in the case of Minnesota by observations along survey lines.

Data on railroad cross-ties, mine timbers, poles, piling, and other minor products were obtained from railroads, wood brokers, mining companies, state highway departments, manufacturers, and other sources. It is believed that a reasonably complete coverage has been made of all industries and plants producing or using timber products of any kind.

In addition to the census of wood production and current consumption, an attempt was made to relate current consumption to the average of recent years. Also, field studies were made to determine the amount of wood lost or wasted in

woods and milling operations in order to translate the output of finished products into terms of standing timber.

Fire Damage

Estimates of annual fire losses were based on the average losses during the past five years as compiled from records of the several State Departments of Conservation. The amount of damage per acre burned was adjusted on the basis of fire damage studies made by the Lake States Forest Experiment Station. In predicting probable future fire losses, allowance was made for improved protection facilities and for a decline in logging and slash menace.

Other Losses

There is little basis for predicting the extent of major accidental losses in timber stands, but it was necessary to make some allowances for such catastrophes in developing long term plans. During the past third of a century there have been several major insect epidemics such as the larch sawfly and spruce budworm infestations. Severe windstorms have been fairly common and occasionally have swept down large blocks of mature timber. A large amount of timber was lost through land clearing. The extent of these losses was roughly determined and was related to the average stand of timber for the period. The same percentage of the present stand was considered liable to accidental destruction.

Attention is called to the fact that the normal year-to-year losses from insects, diseases, and wind already have been provided for in the mortality discount included in the growth calculation. Only the abnormal or catastrophic occurrences which would change the entire nature of the stand need to be accounted for in the depletion item.

Requirements

Long term requirements have been given only incidental consideration in these preliminary Forest Survey reports and will be analyzed in detail only in the final state reports, where the plan of study will be fully outlined.

In general, the determination of probable future requirements will involve an analysis of population, construction trends, rates of replacement, changes in manufacturing methods, and a host of other considerations.

Forest Type Maps

Generalized forest type maps which illustrate the relative proportion and approximate distribution of the major forest types were prepared for the principal forest districts. To a large extent they represent the compilation of all available existing information from a variety of sources. Map data were secured from the Land Economic Surveys of each of the states, from the United States Indian Forest Service, the National Forests, and various divisions of the Conservation Departments of the several states, as well as from aerographic mosaics by the U. S. Geological Survey. All of this information has been assembled, condensed, and platted on a scale of 4 miles to the inch.

Areas not covered by existing data were mapped by the Forest Survey in the field. The work was done by rapid reconnaissance along roads, supplemented by sketching along regular survey lines. No types of less than 40 acres are shown on the final map.

On account of the small scale, a certain amount of generalization was necessary. Thus some of the types for which detailed statistics are shown have been grouped on the map. For example, all pine types have been combined. Black spruce, tamarack, and cedar are all mapped as coniferous swamp. Poor aspen has been combined with grass and brush as being essentially deforested.

RELIABILITY OF STATISTICS

The number of samples needed for a reliable forest inventory depends upon the size of the area and the complexity of the forest conditions. Where forests are very uniform in type and conditions, it is usually considered that from two to four cross-sections of the tract will give a reasonably good estimate of the character of the cover and the volume of the standing timber. This would apply to

a 40-acre tract, to a whole section or to an entire state providing each is reasonably uniform in distribution of types and stand per acre.

However, in going into a large area, an estimator is certain to encounter greater variability in types, size, and composition of forest stands. Thus more cross-sections are necessary to provide an equally reliable estimate of the conditions.

Before starting the Forest Survey, several experiments were carried out to determine the accuracy of surveys with lines spaced at various intervals in large areas. In Menominee County, Michigan, where there was a very detailed cover map available, and where cover conditions are about as variable as anywhere in the Lake States, twenty lines were laid out on the map at 3-mile intervals and the areas of the different types were estimated on the basis of the type proportions found on the lines. These were then compared with the area of the types as actually measured (by planimeter) on the map. In three trials practically all types which amounted to 10 percent or more of the gross county area, were estimated within 5 percent of their true size.

The error for open swamps, which made up $2\frac{1}{2}$ percent of the county area, averaged 20 percent. In one trial the error for open brush land, which made up 1-3/4 percent of the county area, was as much as 60 percent. It averaged 40 percent in the three trials. The plan, therefore, was quite accurate for large types, unreliable for very small types.

In Washburn County, Wisconsin, 18 lines laid out at two-mile intervals, gave similar results. All types which amounted to 10 percent or more of the county area were estimated within 10 percent. The statistical analysis from these sample plots in Washburn County likewise indicated that the total volume could be relied upon within limits of 5 percent. Very similar results were obtained in a group of four Wisconsin counties with lines 6 miles apart.

Accuracy of Area Determinations

In Minnesota, with lines run at 10-mile intervals, there were altogether 38

lines or cross-sections of the State. The survey results were analyzed statistically to determine as well as possible the probable error of sampling. The analysis indicated that the sampling errors were somewhat larger than would be expected from a strictly random sample.[2/] Nevertheless, the analysis indicated that the determination of total forest area should be dependable (2 chances out of 3) within 1.2 percent. (Table 1).

For some of the smaller types standard errors of 10 percent or more were recorded. Within individual economic units, estimates of some of the finer divisions of small types may be seriously in error. But these errors are not cumulative and since no conclusions depend upon these finer divisions the possible discrepancies are not important.

Accuracy of Volume Estimate

To provide a basis for estimating variability in plot volume, an occular estimate of the volume of sawtimber and cordwood was recorded in the field. Tables and rules of thumb in common use by cruisers were employed in obtaining these estimates and while they somewhat overrun the final average computed volumes of the survey, it is believed they are quite adequate. The standard deviations of plot volumes for both board feet and cords were computed for the more important types and conditions and the calculated errors are recorded in columns 3 and 4 of Table 1.

The accuracy of the final estimate of volume by types depends on the error in both area and plot volumes. Columns 5 and 6 show this total error of estimate. Insofar as errors of sampling are concerned, the total estimate of volume should be reliable within 2 percent.

Other Sources of Error

The foregoing discussion applies only to errors of sampling. In any work of this kind the human element enters, and it must be recognized that there will be some errors of measurement, judgment, and calculation. Fortunately, most errors

2/ In other words, on account of having plots at short intervals along widely spaced lines, the sample was of Lexian rather than Bernoulli type. (See "Handbook of Mathematical Statistics," edited by H. L. Rietz. pp. 82-87.)

of this kind are compensating. The following are some of the steps in the Survey which are open to such error.

Plot Tally

Where trees are tallied on circular plots there are opportunities to miss inside trees or include outside trees near the perimeter. There is also the chance to put trees in the wrong diameter class or even miscall the species. As a result of systematic field checks and a system of grading estimators as to accuracy, errors of this kind were kept at a minimum. Most estimators checked within 2 or 3 percent in number of trees, the errors as a rule being only in 5 and 6-inch trees which have relatively little effect upon the volume estimate. These errors tend to be compensating.

Volume Tables

The final volume estimate was based upon the number of trees per acre of various species and diameters and the volume per tree as worked out on a number of sample trees. These local volume tables of average volume per tree were in themselves a sample and they therefore introduced an added sampling error into the volume estimate. The technique of compiling volume tables, however, was such that chance irregularities were fairly well evened out and the likelihood of error due to poor sampling was minimized. Although these errors may be considerable in individual diameter classes and species, they tend to be compensating and should be small for the survey as a whole. Actual limits of error have not been determined.

TABLE 1

SAMPLING ERRORS* IN ESTIMATES

OF FOREST AREAS AND TIMBER VOLUMES

FOREST SURVEY OF MINNESOTA

TYPE	SIZE OF TYPE: Percentage of Total Land Area	Errors in Area Determination	Errors in Determining Vol. per Plot: Bd.Ft.	Errors in Determining Vol. per Plot: Cords	Total Errors in Volume: Bd.Ft.	Total Errors in Volume: Cords
	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.
All timber types	43.19	1.20	1.47	.66	1.90	1.37
Aspen	19.33	2.13	2.06	1.12	2.96	2.40
Hardwoods**	3.95	3.93	2.45	1.73	4.63	4.29
Black spruce	3.74	11.28	6.55	2.43	13.04	11.54
Balsam fir	3.45	8.29	2.96	1.74	8.80	8.47
Pine	3.54	6.87	4.11	1.83	8.00	7.11
Brush	11.43	6.49	--	--	--	--

* The error shown is the standard error expressed as a percentage of the mean.
** Includes maple-basswood, bottomland hardwood and oak types.

Estimates of volume in tops and limbs of sawtimber trees were computed by determining the ratio of such volume to each thousand board feet of sawtimber material. The factors used in this computation were based on relatively few measured trees and are therefore somewhat less reliable than the estimates of merchantable volume.

The determination of utilization limits and cull factors is to quite an extent a matter of judgment. In Michigan and Wisconsin these factors were worked out in a study of actual logging operations and by scaling logs at the mills. It is believed that the survey standards conform very closely with the practices of the better operators in the region.

Growth Assumption

Sample tree measurements for radial growth were carefully made and carefully computed. However, in calculating probably future growth, it was necessary to make certain assumptions which are not subject to immediate check. They were based merel upon careful observation of what has taken place in other similar stands. The growth

estimates, particularly those for the longer periods, therefore must be considered as approximations rather than accurate determinations. Every effort has been made to be realistic in the assumptions and the results seem to check with logic and common sense.

Estimates of Drain

Fire damage forecasts, like growth, must be predicated on past records and never can be accurately forecast. The volume of lumber, pulp and other products cut during past years can be determined with reasonable accuracy, but future cuts will be influenced by many unpredictable factors. Some elements of drain such as severe insect epidemics, which may occur only once in 100 or 200 years, tornadoes, etc., are more or less matters of speculation. It is self evident that estimates of these items cannot be as accurate as the inventory of present volume.

Efforts were made to carry out all phases of the Survey as carefully as possible with the resources available and consistent with the nature of the data which could be obtained. The aims were to gather sufficiently accurate statistics to portray the forest situation in each unit in realistic terms to give a suitable basis for a long range forest program. It is believed that these aims have been accomplished.

DEFINITIONS OF TERMS

Volume Classification

Timber volumes were computed in terms of board feet of sawtimber, cords of pulpwood, cedar piece products, and total cubic feet.

Sawtimber

Volume of sawtimber was measured in terms of board feet, by use of the Scribner Decimal "C" log rule. Board foot volume was computed for all trees 9 inches or more in diameter, which contained at least a 10-foot log of good quality or a 16-foot log of poor quality. Minimum log diameters were 6 inches in soft-

wood species and aspen, and 8 inches in hardwoods.

Inasmuch as the volume as scaled by the Scribner rule under-runs the amount of lumber actually produced at the mill, volumes were also computed in terms of the International ($\frac{1}{8}$" kerf) Log Rule. The latter has been found to approximate lumber tally very closely.

For most trees the top diameter was considerably greater than 8 inches because the limit of merchantability was determined by branches, forks, etc., rather than by diameter. A large proportion of the small size logs of pulpwood species were estimated as pulpwood rather than sawlogs.

Allowance was made for defect, decay, sweep, breakage, and other shrinkage, so that the recorded volumes are the net merchantable volumes.

Pulpwood

Pulpwood volume was estimated in standard cords 4'x 4'x 8', assuming the wood to be piled with the bark on. Only species commonly used for pulpwood in the Lake States were included in the pulpwood estimate. These included spruces, balsam fir, jack pine, hemlock, tamarack, and aspen. No wood in trees less than 5 inches in diameter at breast height was considered merchantable.

The pulpwood volume included wood unsuitable for sawtimber, provided that at least two 8-foot sticks could be cut from small trees or one 8-foot stick from the tops of sawlog trees.

In the case of aspen and hemlock no wood smaller than 5 inches inside bark was estimated as pulpwood. In other species a 4-inch minimum diameter was used.

Cedar Products

Cedar was estimated in terms of poles and posts. The standards for cedar poles conform to the specifications of the Northern White Cedar Association. They range in length from 16 feet to 40 feet. Minimum and maximum top diameters vary with the length of the pole from $4\frac{1}{2}$ inches to 9 inches.

Cedar posts are 7 feet long, with a minimum top diameter of 4 inches.

The material estimated as split cedar posts included all wood 4 inches

and larger in diameter which was unsuitable for either poles or round posts. Some of this volume is usable for dimension stock, shingle stock, ties, and sawed miscellaneous products. A large proportion, however, is usable only for lagging or other split products.

Cedar trees which could produce at least a 16-foot pole, two posts, 14 lineal feet of reasonably straight splitting material, or a tie-cut, were tallied as sound trees. Those too crooked or rotten to meet these qualifications were culled.

Total Cubic Feet

Total cubic foot volumes included all wood, exclusive of bark, which lay between the stump and a top diameter of 4 inches inside bark. In hardwoods, limbwood larger than 4 inches as well as the main stem was included. The cubic volume of cull trees was excluded from the volume estimates, except where explicitly pointed out in the tables.

Tops and Limbs

Tops and limbs included the volume of wood lying above sawlogs in sawtimber trees. In conifers it included only topwood in the main stem; in hardwoods, both topwood and limbwood. Only wood 4 inches or larger in diameter inside bark was included.

A part of the topwood in conifers is suitable for pulpwood. This fraction was included in both the pulpwood volumes and in the volume of tops and limbs.

Small Trees

Small trees are those having a diameter at breast height of at least 5.0 inches but which are too small to produce a sawlog of minimum size. All 6- and 8-inch trees were grouped under this heading. Pulpwood volume in such trees was included in both pulpwood volumes and in volumes of small trees.

Cull Volume

Cull volume includes the total cubic volume of cull trees as well as that

fraction of merchantable trees which is allowed for woods cull and mill losses.

Hardwood Log Grades

High Quality Logs

High quality logs must be at least 10 feet long and not less than 8 inches at the small end. The poorest logs in this grade must be at least 75 percent sound and yield 30 percent or more No. 1 common or better lumber. Logs less than 10 inches in diameter are required to be surface-clear, straight, and sound.

Low Quality Logs

Low quality logs do not meet the above specifications but must be 8 feet or longer, 8 inches at the small end, 50 percent sound and suitable for production of tie cuts or low grade lumber, such as box and crating material. These logs correspond closely to the poorest grade logs now being utilized on operations practicing close utilization.

Sawlogs of pine, hemlock and other conifers were not graded. Poor quality logs of balsam fir, tamarack, spruce, jack pine, hemlock and aspen were classified as pulpwood and were excluded from the sawtimber volume.

AREA CLASSIFICATION

Forest areas were classified as to condition of the timber stand and the character of the forest cover, as determined from the 1/5 acre sample plots.

Condition Classes (Size Classes)

Sawtimber. Any stand which had 2,000 board feet or more per acre of sawtimber was classified as a sawtimber stand. If 50 percent or more of the volume occurred in trees over 15 inches in diameter at breast height, the stand was classified as Old Growth Sawtimber; if more than half of the volume occurred in trees less than 15 inches D.B.H., the stand was rated Second Growth Sawtimber.

Cordwood. A stand containing less than 2,000 board feet of sawtimber but having 3 cords or more per acre of small non-sawlog trees was classified as a cordwood stand.

Reproduction. If there were less than 3 cords per acre of cordwood trees and less than 2,000 board feet of sawtimber, the stand was rated as Reproduction, provided that at least 10 percent of the available growing space was occupied by small trees of commercial species.

Deforested. Forest lands which had at some time been timbered but which now qualify for none of the condition classes defined above, were rated as Deforested.

Cover Types

Twenty-two cover types were recognized. They are defined as follows:

1. Jack Pine. Jack pine is the predominant* species.
2. Norway Pine. Norway pine is the predominant species.
3. White Pine. White pine is the predominant species.
4. Northern Hardwoods or Hemlock-Hardwood. This is a "mixed" type in which the principal species are sugar maple, hemlock, yellow birch, basswood and beech. Other associated species which occur in lesser proportions are white pine, red oak, balsam fir, ironwood, elm and cedar. The type may vary in composition from a mixture of all species to almost pure stands of any one of the key species. The key species must collectively predominate to qualify for this type. Pure stands of hemlock are considered a variation of this type.
5. Oak or Central Hardwoods. This is a mixed type characterized by white, red, and bur oaks in association with maple, basswood, and other hardwoods. It is typical of the Central States but is common only in the southern portion of the Lake States.

*The term "predominant" as used in these definitions means 50 percent or more of the total volume in cordwood and sawtimber stands or more than 50 percent of the unsuppressed trees in reproduction stands. Where no single species or key group of species clearly predominates, preference is given to the more valuable types.

6. Scrub Oak. The predominating species are jack, white, red, scarlet, black, and bur oak of very poor form. The type is typically restricted to dry, sandy, or gravelly soils.

7. Aspen - Birch. Aspen and paper birch, either singly or together, make up more than 50 percent of the stand.

8. Bottomland Hardwoods. Occurs in shallow swamps, overflow lands, or "second bottoms". The characteristic species of this type are black ash, American elm, and soft maples. Associates in the swamps of the northern part of the Lake States include balm-of-Gilead, yellow birch, green ash, cedar, hemlock, spruce, and occasional other hardwoods.

On the alluvial bottoms in the southern part of the region the associated species are black walnut, butternut, willow, hackberry, balsam poplar, river birch, and swamp white oak.

9. Juniper. This is an infrequent type on bluff areas in the southern part of the region. Eastern red cedar is the key species.

10. Spruce-Balsam. This type is typically a mixture of white spruce, balsam fir, white cedar, paper birch, aspen, black ash, and sometimes yellow birch, hemlock or pine. It occurs on cool, moist uplands or along swamp borders.

11. Spruce Swamp. This type is closely confined to acid peat bogs with poor drainage and is thus distinguished from the spruce-balsam type which grows on upland soils. Black spruce may occur in pure stands or mixed with balsam fir, tamarack and cedar.

12. Tamarack Swamps. This type is very similar to the spruce swamp type in characteristic associates and site, but tamarack predominates.

13. Cedar Swamps. This type occurs on shallow peat having some drainage. Swamp species, including spruce, balsam fir, tamarack, and paper birch, are commonly associated with it and not infrequently yellow birch, black

ash, red maple, and white pine are also found. (Note: a mixture of cedar and other conifers on upland sites is classified under the spruce-balsam type).

14. Non-Productive Swamp. Scrubby spruce or tamarack on deep, poorly drained peat, usually less than 5 inches D.B.H. at 100 years of age. This type does not include deforested but potentially productive peat lands.

15. Grass or Light Brush. This includes areas of grass, bracken, fern, sweet fern and light brush cover on once-forested land.

16. Brush. Areas grown up to heavy brush cover so that planting would be difficult. This type also includes much of the deforested swamp land.

17. Wooded Pasture. All pastured lands inside of farms which s pport less than 2,000 board feet or 3 cords per acre, but which bear some trees, are called wooded pasture.

Non-Forest Types

18. Marsh or Bog. These are naturally non-forest areas - not deforested land. This type includes areas in rushes, sedges, or brush such as alder, scrubby willow, leatherleaf and Labrador tea.

19. Barren or Waste. Rock outcrops, beaches, dunes, etc., are classified as barren lands.

20. Water and Flowage. Other than meandered waters.

21. Agricultural Land. Improved crop land, plowable pasture, farmsteads, and natural meadows outside of farms commonly used for hay land are grouped under this heading.

22. Industrial and Residential. This general heading is subdivided into:

(a) Urban and Platted. The acreage and location of urban and platted areas were determined from records on file at the county seats. Platted recreational areas are not included under this heading,

nor are plats of the several undeveloped "boom" projects of southern Michigan.

(b) Rights-of-Way. The acreage of roads and highways was based on data from the State and County Highway Departments. Acreage in railroad rights-of-way were computed from standard railroad maps.

(c) Miscellaneous Industrial and Residential. These areas include cemeteries, mines, gravel pits, summer homes, resorts, and residences other than urban or farmstead.

Ownership Classes

Statistics on ownership of lands and timber are presented only by groups of owners. These are defined as follows:

Federal - National forest, vacant public domain, federal wild life refuges, and any other properties owned directly by the federal government.

Indian - Tribal lands and allotments held in trust for the Indians. Patented allotments were considered to be in private ownership.

County - Land owned by the counties - highways not included.

Large Private - Land owned by individuals or corporations having at least 2,000 acres each (1800 acres in Minnesota).

Small Private - Land owned by individuals or corporations having less than 2,000 acres each.

State - In Minnesota, all trust lands as well as delinquent contract sales, Rural Credits, game refuge purchases, and "Reforestation and Flood Control" lands were considered State lands.

In Michigan, only lands listed in records of the Auditor General and Conservation Department were classified as State land.

Classification of Species

Separate estimates have been kept for all of the more important species.

A few closely related hardwood species, however, have been grouped. Others which do not occur in significant quantities or which are of little value, have been grouped under the general heading, "Miscellaneous". Altogether 22 species or species groups were recognized:

Species Group	Common Name	Botanical Name
Jack pine	Jack pine	Pinus banksiana
Norway pine	Norway pine	Pinus resinosa
White pine	White pine	Pinus strobus
Hemlock	Hemlock	Tsuga canadensis
Balsam	Balsam	Abies balsamea
Black spruce	Black spruce	Picea mariana
White spruce	White spruce	Picea canadensis
White cedar	White cedar	Thuja occidentalis
Red cedar	Eastern red cedar	Juniperus virginiana
Tamarack	Tamarack	Larix laricina
Sugar maple	Sugar maple	Acer saccharum
Birch	Yellow birch	Betula lutea
	Black birch	Betula lenta
Basswood	Basswood	Tilia glabra
Elm	American elm	Ulmus americana
	Rock elm	Ulmus racemosa
	Slippery elm	Ulmus fulva
Red oak	Red oak	Quercus borealis
	Black oak	Quercus valutina
White oak	White oak	Quercus alba
	Bur oak	Quercus macrocarpa

Species Group	Common Name	Botanical Name
Beech	Beech	Fagus grandifolia
Miscellaneous Better Hardwoods	Butternut	Juglans cinerea
	Black walnut	Juglans nigra
	Black cherry	Prunus serotina
	Hickory	Hicoria spp.
	White ash	Fraxinus americana
	Hackberry	Celtis occidentalis
	Locust	Robinia pseudoacacia
	Ohio buckeye	Aesculus glabra
	Yellow poplar	Lirodendron tulipifera
	Sycamore	Platanus occidentalis
	Kentucky coffee-tree	Gymnocladus dioica
	Honey locust	Gleditsia triacanthos
	Chestnut	Castanea dentata
Poplar	Aspen	Populus tremuloides
	L. T. Aspen	Populus grandidentata
	Balm-of-Gilead	Populus balsamifera
	Cottonwood	Populus deltoides
Paper birch	Paper birch	Betula papyrifera
Soft maple	Red maple	Acer rubra
	Silver maple	Acer saccharinum
	Box elder	Acer negundo
Scrub oak	Scrub oak	Quercus ellipsoidalis
		Quercus sp. (poor form)

Species Group	Common Name	Botanical Name
Miscellaneous Inferior Hardwoods	Black ash	Fraxinus nigra
	Green ash	Fraxinus lanceolata
	Ironwood	Ostrya virginiana
	Willow	Salix nigra

A few species which seldom attain merchantable size were not included in timber estimates. These are blue beech, red or pin cherry, mountain ash, hawthorn, wild plum, shrub willows, dogwood, witch hazel, alder, striped maple, and mountain maple.

It is possible that species other than those mentioned above occur in the Lake States, but they were not encountered in the Survey.

The common names of trees as used above are those recognized by the Forest Service in its "Check List of Forest Trees", U. S. Department of Agriculture Miscellaneous Circular 92.

Growth Estimates

Growth is computed on two bases:

Current Annual Growth represents the average net growth during the next 10 years. It is concerned only with the short-term outlook for existing stands, and should not be taken to indicate average log-term rates of growth.

Mean Annual Growth represents the average annual growth for the entire life of a stand. It is thus equivalent to the total volume of the stand, divided by its total age. In Forest Survey reports, rotation ages, i.e., the number of years required for trees to grow from seed to maturity, were assumed for the various forest cover types, and these were used in computing mean annual growth.

Mean annual growth indicates the long-term productivity of the various cover types, in contrast to the short-term outlook portrayed by the current annual growth for the next 10 years.

Yield tables show the expected volumes at successive ages in the life of the stand and therefore serve as a basis for computing either current or mean annual growth.

All growth estimates are net volumes, i.e., allowance has been made for all cull and milling losses, as well as for natural mortality of trees during the life of the stand.

Depletion Estimates

Normal drain is comparable to current annual growth in that it represents the probable annual drain during the next 10 years. It is not a long-term prediction.